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## Summary

Inactivity is the risk factor with potentially the greatest public health impact according to the 1989 U.S. Preventive Services Task Force report. This study reports changes in the physical fitness level following simple changes aimed at enabling community members to more easily adapt active life-styles.

Simple environmental and social alterations were made at a San Diego Naval Air Station. A cohort of active-duty personnel from within this community (n=1,609) was administered both a physical readiness test (PRT) and a lifestyle questionnaire at baseline and at one year. The PRT consisted of a 1.5-mile timed run, sit-ups, push-ups, and percent body fat components, while the questionnaire addressed demographics, current exercise behavior, and attitudes toward exercise. Similar measures were taken within a comparison community cohort (n=217) and within a Navy-wide sample cohort (n=546).

Overall PRT category and 1.5-mile run time both improved significantly ($P<.05$) over time at the intervention community (0.3 category points and 18 seconds, respectively). The increase was significantly greater ($P<.01$) than at either the control community or within the Navy-wide sample. Subgroup analysis showed that at the intervention community 12.4% failed the overall fitness test in 1987, but only 5.1% failed in 1988. Similarly, the 1.5-mile run failures decreased from 8.4% to 4%. Reported leisure time kilocalorie expenditure showed no significant improvement.

This simple program was successful in improving fitness performance. The improvement was distributed throughout the community and included those who were substandard at baseline. Similar programs could easily be adopted in a variety of communities.

## Physical Fitness Gains Following Simple Environmental Change

Jerry M. Linenger, Charles V. Chesson, D. Stephen Nice

### Introduction

The U.S. Preventive Services Task Force, after performing meta-analysis of 43 studies, found that coronary heart disease (CHD) is 1.9 times as likely to develop in a physically inactive person than in a physically active person.[1] They noted that persons who are physically active on a regular basis live an average of two years longer than physically inactive persons and have a lower death rate from a variety of causes. They also suggested that the most significant potential health gains from exercise could be achieved by those who are presently most ill-conditioned and/or sedentary.

Fostering greater physical activity in large segments of the population thus becomes critical. The Office of Disease Prevention and Health Promotion recommends that due to (1) the widespread prevalence of risk factors across the population and (2) the difficulties in targeting high-risk populations, the best approach is to intervene across entire populations.[2] A community or public health intervention model may be more effective in producing the widespread exercise changes.[3] These programs should systematically introduce risk-factor modifying interventions aimed not at specific clusters in the target population, but rather at the entire worksite or the community as a whole. Targeting specific subgroup clusters has not proven cost-effective due to the huge population burden of cardiovascular vascular disease and to the inability to segregate effectively those at higher risk from the generally high-risk background population.[2] In this report, a simple environmental/social change program designed to facilitate a more active lifestyle is evaluated.

### Methods

Design. The study was conducted in a prospective manner using before-and-after measures. It compared changes in fitness in a San Diego, CA intervention community to a Sunnyvale, CA control community and to a Navy-wide sample over a one-year period. The communities were selected to be similar based on the following criteria: (1) size, (2) aviation

mission, (3) mix of personnel, (4) climatic conditions, and (5) comparable facilities.

The study proceeded as follows: (1) the three cohorts were administered both a physical readiness test (PRT) and a questionnaire over a two-month period, (2) the intervention community underwent environmental and social interventions aimed at lessening the barriers to increased activity, and (3) the PRT and questionnaire were repeated one year after baseline. The primary measure was a change in the 1.5-mile run time and overall physical readiness test (PRT) score from baseline until one year. Secondary outcomes included changes in attitudes and/or knowledge concerning the importance of fitness, the utility of exercise, and the self-rating of current fitness. Changes in the average number of kilocalories (kcals) expended per week were also assessed. Variables considered for control were gender, age, officer/enlisted status, paygrade, education, marital status, and baseline performance.

Following the National Institute of Health's National Heart, Lung, and Blood Institute's and National Cancer Institute's guidelines for research phases for the development of health promotion programs as integrated by Flay, the study is a phase IV prototype study.[4] As defined, phase IV prototype studies are either experimental or quasi-experimental tests of complete programs, using a small number of aggregate units (e.g. worksites, schools, or communities) per condition, with measures that include behavioral outcomes. The proposed study meets the criteria measuring behavior change by both objective Physical Readiness Test (PRT) results and subjective (survey response) methods. By U.S. Preventive Services Task Force criteria modified from those originally developed by the Canadian Task Force on the Periodic Health Examination, it meets grade II-2 rules of evidence: comparison between time or places with or without intervention.[5]

**Study population.** Since the intervention was applied to the entire community, all active duty military personnel were initially eligible to be included in the study. If a squadron was deployed during the initial two-month testing period (deployment usually lasting six months), all members of the squadron were considered ineligible. Within eligible squadrons, baseline physical readiness test (PRT) and survey were given

only to those individuals who were not expecting transfer orders for at least six months. Surveys were completed only by those individuals eligible for PRT testing during the two-month testing period. The major reasons for missing squadron PRT testing included vacation, awaiting required medical screening, short-term duty away from the squadron, or previous PRT testing within the four prior months. PRT testing is a mandatory semi-annual requirement for all Naval personnel. Individuals do not have the option to refuse testing.

As shown in Table 1, of the 10,500 military personnel stationed at the intervention worksite, approximately 7,875 were eligible to be tested. Only 3,402 received their PRT during the 2-month testing period. Of these, 1,609 completed testing one year later for a 47% follow-up rate.

The control 1 community (Naval Air Station Moffett) had 5,250 active duty members. Approximately 3,937 were eligible for testing at baseline, with 326 reports of completed PRT's obtained during the 2-month 1987 data-collection period. Of this group, 217 completed testing one year later for a 67% follow-up rate. The primary reason for not obtaining more testing results at baseline was that the test had already been completed within the previous four months and that the squadrons at this location were unwilling to repeat testing for study purposes only. Logistical problems and inter-organizational lack of cooperation also contributed to the low baseline coverage at this site.

Another investigator studied worldwide Navy trends in PRT performance using a random sample of Navy active duty personnel.[6] The sample consisted of a dynamic cohort with a fitness test administered every six months and a survey yearly. Using these data, subjects with 1987 PRT results were selected to comprise control group 2. Of the 1,250 with PRT results recorded in 1987, 546 (44%) were followed through 1988.

**Data analysis.** An edit program which checked for out of range values was used to flag outliers. Outliers were then evaluated using the hard copy questionnaires and fitness test recording forms. The data were entered and stored on a VAX minicomputer at the Naval Health Research Center, San Diego. Analyses were done using the SPSSx Informational Analysis System (SPSSx, 1988). Descriptive statistics were done for

Table 1 - Cohort Selection Process for NAS North Island (intervention), NAS Moffett (control 1) and Navy-Wide Sample (control 2)

| | NAS NORTH ISLAND (intervention) | NAS MOFFETT (control 1) | NAVY-WIDE Sample (control 2) |
|---|---|---|---|
| Avg. daily count | 10,500 | 5,250 | 605,000 |
| # eligible at baseline[1] | 7,875 | 3,937 | N/A |
| # reporting results of fitness testing during the 2 month 1987 data collection period[2] | 3,402 | 326 | 1,250 |
| Cohort (# completing fitness testing at both time 1 and time 2) | 1,609 | 217 | 546 |
| Cohort % follow-up | 47% | 67% | 44% |
| % within cohort completing both questionnaires | 69.9% | 32.3% | 58.1% |

NOTES:

1. Satisfying entry criteria of not being scheduled to (1) leave the Navy or (2) change duty station or (3) deploy with their unit within six months of initial testing.

2. Fitness testing is required to be done every six months.

3. Navy-wide sample selected by a two-step process. The first step selected 119 command units from approximately 5,000 in the Navy. Second, individuals were randomly selected from each of the 119 command units.

overall PRT score, each component PRT score, demographics, and questionnaire data. Plots of the distributions were made and assessed for normality. Both maximal aerobic capacity and run times have been shown to be both age- and sex-dependent.[7-8] Performance on both the 1.5-mile run and the overall physical readiness test (PRT) have been shown to be both age- and sex-dependent in the U.S. Navy population.[9] Since the three cohorts do not share identical age and sex distributions, all comparisons were made after weighting for both age and sex. A direct weighting method was used, setting the entire U.S. Navy in 1988 (n = 605,000) as the standard population.

The repeated measures MANOVA procedure was used to test for differences between the intervention and control groups for overall physical readiness test (PRT) score, PRT component scores, total leisure time kcals expended per week, and questionnaire response items. All comparisons were made between the three cohorts. The use of two control groups should strengthen the validity of any result since the similar worksite and the Navy-wide sample provide a good estimate of the overall fitness trends within the U.S. Navy. Statistical significance (F test) of changes over time within the cohorts as well as differences over time among all three cohorts were tested. The interaction F-statistic reflects any difference between the three cohorts (i.e., including differences between the two control groups) and must be interpreted based on the change values for the three groups.

Questionnaire items regarding exercise behavior, knowledge, and attitudes toward fitness were scaled into four major categories: perceived top level support for fitness programs, personal importance of fitness, perceived utility of exercise, and opportunity to exercise. A single response item measuring the self-rating of current fitness was also reported.

Treatment. During the study period, personnel at the intervention community were exposed to an environment that emphasized and supported more active life-styles. Unless the environment is supportive of life-style change, success in reaching individual goals is limited.[10] While many health promotion programs attempt to change behavior through various individual motivational techniques and through education

programs aimed at producing healthy life-styles, few actually attempt to alter the surroundings.[11-17]

Some of the specific environmental interventions introduced at the intervention community included:

- Bicycle paths built along roadways
- Extended hours at recreation facilities
- New exercise equipment purchased at gyms
- Numerous base-wide athletic events scheduled
- Running and bicycling clubs organized
- 1.5-mile run courses marked at various sites
- Women's fitness center opened
- Highly visible and convenient placement of healthy foods, including salad bar, fruits and low-calorie drinks
- Low visibility and less convenient placement of high-fat food items, dessert bars and high-salt snack foods
- Nutrition information pamphlets placed on dining tables
- "Best for You" color-coded labeling system at base commissary (different colors to identify low fat, salt, and cholesterol)
- Base snack shops offering salad bars, fruit, and whole wheat items
- No smoking rule enforced aboard aircraft and inside buildings

These measures were aimed at improving physical fitness and general health by removing barriers to change. While these simple "enabling" changes were the backbone of the intervention, some social changes also were incorporated. Higher level commands continually stressed the expectancy of improved performance, encouraged release time for exercise, emphasized the importance of improved appearance for future transfer and promotion, and stressed that individuals would be held accountable for their own fitness. Sustained superior performance or improved performance over previous test results was rewarded with Certificates of Achievement. The local newspaper listed the top performers in each category of testing, while higher levels of command acknowledged superior squadron performance with Certificates of Achievement. A software program was developed to allow ranking of all individuals by either overall test score or test score by category. This system provided timely feedback to both the individual tested as well as to the squadron regarding their relative standing. Finally, the Fitness Center staff organized numerous races, competitions, and remedial programs.

## Results

**Demographics.** The intervention community cohort (Naval Air Station, North Island, NASNI) consisted of 1,609 people with a mean age of 28.6 years. It was predominantly male (85%), Caucasian (69%), high-school educated (69.9%), with 54.4% married and 9.5% widowed or divorced. The majority (85.5%) were enlisted (Table 2).

The comparison community (Naval Air Station Moffett Field, control 1) cohort numbered 217 with a mean age of 28.4. It had a higher male percentage (89.9%), enlisted (92.6%), high-school educated (74.5%) Caucasian, (76.7%), and married (62.7%) than the intervention cohort. A similar percentage to NASNI (9.2%) were divorced or separated. Overall, the differences were very slight between these two communities.

The Navy-wide sample (n=546) had an older mean age (30.4 years) than either worksite group. They were also more educated, with 55.1% of the sample with greater than 12 years of education and only 1% with less than a high-school education. The sample also contained fewer enlisted personnel (77.8%) than the two community cohorts. More of its members were married (69.2%) with slightly less separated or divorced.

**Physical fitness changes.** Within the intervention community (NASNI), there were statistically significant changes ($P<.05$) from 1987 until 1988 for both primary outcome measures (Table 3). The 1.5-mile run time improved by a mean of 18 seconds, while overall PRT score gained 0.3 points on the four point failure-to-outstanding scale. Statistically significant changes ($P<.05$) were also observed for some of the secondary outcome measures. Sit-ups improved by 1.9 sit-ups per 2 minutes, while pushups improved by 2.5 push-ups per 2 minutes. There was no change in percent body fat. The only other statistically significant change ($P<.05$) from 1987 to 1988 occurred in control group 1 (NAS Moffett) where the percent body fat increased by 1% over the year.

Overall PRT scores show a positive significant ($F=18.2$, $P>.01$) main effect for time and a significant ($F=10.4$, $P<.01$) (Table 4) time by group interaction. Similarly, the 1.5-mile run times show a significant ($F=4.3$, $P<.05$) effect for time and a significant ($F=13.7$, $P<.01$) time by group interaction in the direction of faster run times.

Of the secondary measures, statistically significant findings were seen for push-ups where all three groups improved: NAS Moffett (control

Table 2 - Demographic Summary of the Three Cohorts and the Entire U.S. Navy in 1988

| | NAS North Island (intervention) | NAS Moffett (control 1) | Navy-Wide Sample (control 2) | U.S. Navy |
|---|---|---|---|---|
| **AGE** (years) | | | | |
| Mean | 28.6 | 28.4 | 30.4 | 27.0 |
| St dev | 6.3 | 6.0 | 7.2 | — |
| Range | 18–53 | 19–46 | 18–56 | 17–65 |
| N | 1609 | 217 | 545 | 608,102 |
| **SEX** (percent) | | | | |
| Male | 85.1 | 89.9 | 85.3 | 91 |
| Female | 14.9 | 10.1 | 14.7 | 9 |
| N | 1609 | 217 | 546 | 605,681 |
| **PAYGRADE** (percent) | | | | |
| Officer | 14.5 | 7.4 | 22.2 | 12 |
| Enlisted | 85.5 | 92.6 | 77.8 | 88 |
| N | 1609 | 217 | 546 | 605,681 |
| **EDUCATION** (percent) | | | | |
| <12 yrs | 3.7 | 4.6 | 1.1 | 6 |
| 12 yrs | 69.9 | 74.5 | 43.8 | 73 |
| >12 yrs | 26.5 | 20.9 | 55.1 | 21 |
| N | 1507 | 216 | 372 | 600,272 |
| **RACE** (percent) | | | | |
| White | 69.0 | 76.7 | 85.5 | — |
| Black | 12.2 | 11.7 | 12.5 | — |
| Other | 18.8 | 11.6 | 2.0 | — |
| N | 1150 | 63 | 392 | — |
| **MARITAL** (percent) | | | | |
| Single | 36.0 | 28.1 | 22.2 | — |
| Married | 54.4 | 62.7 | 69.2 | — |
| Separated/Divorced/Widowed | 9.5 | 9.2 | 8.6 | — |
| N | 1523 | 217 | 464 | — |

Table 3 - Mean Adjusted[1] Changes in Fitness Parameters for Participants at NAS North Island, NAS Moffett (control 1), and Navy-Wide Sample (control 2) in 1987 and 1988

| Assessment Areas | | 1987 | 1988 | Change |
|---|---|---|---|---|
| 1.5 Mile Run (minutes) | NAS North Island | 12.6 | 12.3 | -0.3* |
| | NAS Moffett | 12.3 | 12.2 | -0.1 |
| | Navy-Wide Sample | 12.1 | 12.2 | +0.1 |
| Push-ups (# per 2 minutes) | NAS North Island | 41.5 | 44.0 | +2.5* |
| | NAS Moffett | 40.3 | 43.6 | +3.3 |
| | Navy-Wide Sample | 40.8 | 41.7 | +1.7 |
| Sit-ups (# per 2 minutes) | NAS North Island | 60.6 | 62.5 | +1.9* |
| | NAS Moffett | 58.2 | 58.6 | +0.4 |
| | Navy-Wide Sample | 58.8 | 59.5 | +0.7 |
| % Body Fat | NAS North Island | 15.7 | 15.7 | 0.0 |
| | NAS Moffett | 15.7 | 16.7 | +1.0* |
| | Navy-Wide Sample | 15.9 | 16.0 | +0.1 |
| Overall Physical Readiness Test (PRT) category Score[2] | NAS North Island | 1.8 | 2.1 | +0.3* |
| | NAS Moffett | 1.6 | 1.7 | +0.1 |
| | Navy-Wide Sample | 1.9 | 2.0 | +0.1 |
| Leisure-time Kcals expended per week | NAS North Island | 4140 | 3864 | -276 |
| | NAS Moffett | 3983 | 3029 | -954 |
| | Navy-Wide Sample | 3719 | 3506 | -213 |

[1] Adjusted to the entire U.S. Navy population in 1988 for age and sex.

[2] Physical Readiness Test (PRT) score categories are as follows: 0=Failure 1=Satisfactory 2=Good 3=Excellent 4=Outstanding. The score represents a composite of 1.5 mile run time, push-up, sit-up, and percent body fat scores.

* Significant change ($p<.05$) from 1987 to 1988.

Table 4 - Mean Adjusted[1] Physical Readiness Test (PRT) Scores with 95% Confidence Intervals and Univariate F Scores for NAS North Island (intervention), NAS Moffett (control 1), and Navy-Wide Sample (control 2)

| | NAS NORTH ISLAND | | NAS MOFFETT | | NAVY-WIDE SAMPLE | | TIME F | GROUP F | TIMEXGROUP F |
|---|---|---|---|---|---|---|---|---|---|
| | 1987 | 1988 | 1987 | 1988 | 1987 | 1988 | | | |
| 1.5 mile run (minutes) | 12.6 (12.5-12.6) | 12.3 (12.2-12.4) | 12.3 (12.0-12.5) | 12.2 (11.9-12.5) | 12.1 (11.9-12.2) | 12.2 (12.0-12.3) | 4.3* | 6.9** | 13.7** |
| Sit-ups (# in 2 min) | 60.6 (59.8-61.5) | 62.5 (61.6-63.5) | 58.2 (55.6-60.8) | 58.6 (56.0-61.2) | 58.8 (57.1-60.4) | 59.5 (57.8-61.6) | 5.1* | 6.4** | 1.8 |
| Push-ups (# in 2 min) | 41.5 (40.8-42.2) | 44 (43.2-44.8) | 40.3 (38.3-42.3) | 43.6 (41.2-46.0) | 40.8 (39.3-42.3) | 41.7 (40.3-43.2) | 36.8** | 2.2 | 3.7* |
| Percent Body Fat | 15.7 (15.4-16.0) | 15.7 (15.4-16.0) | 15.7 (15.4-16.0) | 16.7 (16.0-17.5) | 15.9 (15.4-16.4) | 16.0 (15.6-16.5) | 16.1** | 1.0 | 8.7** |
| Overall Physical Readiness Test (PRT) Score[2] | 1.8 (1.8-1.9) | 2.1 (2.0-2.1) | 1.6 (1.4-1.8) | 1.7 (1.5-1.9) | 1.9 (1.8-2.1) | 2.0 (1.9-2.1) | 18.2** | 6.0** | 10.4** |

[1] Adjusted to the entire U.S. Navy population in 1988 for age and sex.

[2] Physical Readiness Test (PRT) score categories are as follows: 0=Failure 1=Satisfactory 2=Good 3=Excellent 4=Outstanding. The score represents a composite of 1.5 mile run, sit-up, push-up, and percent body fat scores.

* $p < .05$

** $p < .01$

1) +3.3, NASNI (intervention) +2.5, and Navy-wide (control 2) +1.7, with significant time (F=36.8, P<.01) and time by group interaction (F=3.7, P<.05) (Table 4). Average percent body fat remained unchanged within the intervention cohort, but increased in both control 1 and control 2 (+1.0%, +0.1%), for a significant time by group interaction (F=8.7, P<.01).

Given the above statistically significant changes in both primary outcome measures (1.5-mile run and overall PRT category score), Tables 5 and 6 are useful in partially assessing which subgroup appears to have benefited most from the intervention. For the intervention community, while 8.4% failed the 1.5-mile run at baseline, only 4.0% failed in 1988 (Table 5). Improvement was seen in both males and females, within each age category, and among both officers and enlisted personnel. Concerning the overall PRT category scores, while 12.4% failed at the intervention worksite in 1987, only 5.1% failed in 1988 (Table 6). While 13% of males failed in 1987, only 5.0% failed in 1988. For females, a smaller reduction (6.7% to 5.3%) was observed. When interpreting these results, two factors should be considered: the much smaller n (1,462 males versus 134 females) and the fewer initial failures for females. Furthermore, any subgroup analysis for control 1 (NAS Moffett) should be cautiously interpreted due to the small numbers in many of the subgroup cells.

Also of interest is the effect of the intervention on those who scored poorly at baseline in 1987 (Table 7). Selecting only those who scored in failure, satisfactory, or good categories, in the combined three groups, improvement was seen from 1987 until 1988 in the 1.5-mile run category score (intervention: 0.3, control 1: 0.2, control 2: 0.1) and overall PRT category score (intervention: 0.4, control 1: 0.2, control 2: 0.2). Time by group interaction for the 1.5-mile run category was significant (F=9.3, P<.01) as well as the overall PRT time by group interaction (F=5.2, P<.01).

**Leisure time kilocalories expended.** In 1987, the average weekly kcal expenditure at the intervention worksite was 4,140 kcals. Reported expenditure in 1988 was 3,864 kcals, showing a statistically nonsignificant overall mean drop of 276 kcals. Similarly, both the worksite control cohort and Navy-wide sample cohort experienced

Table 5 - Weighted[1] Summary of 1.5 Mile Run Categories at NAS North Island (intervention), NAS Moffett (control 1), and Navy-wide Sample (control 2) in 1987, 1988 in Percentages

| | Group | | 0 | 1 | 2 | 3 | 4 | Mean | SD | N |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Fail | Satisfactory | Good | Excellent | Outstanding | (category) | (category) | |
| **Overall** | | | | | | | | | | |
| | NAS NI | 1987 | 8.4 | 41.3 | 33.5 | 14.7 | 2.1 | 1.61 | .910 | 1453 |
| | | 1988 | 4.0 | 38.5 | 37.1 | 15.8 | 4.7 | 1.79 | .918 | 1561 |
| | NAS MFT | 1987 | 8.4 | 34.7 | 34.7 | 16.9 | 5.3 | 1.76 | 1.006 | 209 |
| | | 1988 | 1.7 | 44.9 | 27.9 | 22.1 | 3.4 | 1.80 | .916 | 212 |
| | Navy-Wide | 1987 | 2.5 | 38.3 | 34.9 | 18.9 | 5.4 | 1.86 | .933 | 506 |
| | | 1988 | 4.8 | 39.9 | 30.1 | 18.4 | 6.8 | 1.83 | 1.009 | 511 |
| **Sex** | | | | | | | | | | |
| Male | NAS NI | 1987 | 8.7 | 41.5 | 33.5 | 14.2 | 2.1 | 1.59 | .908 | 1234 |
| | | 1988 | 4.1 | 38.6 | 37.2 | 15.6 | 4.5 | 1.78 | .915 | 1331 |
| | NAS MFT | 1987 | 8.6 | 35.7 | 35.4 | 15.3 | 5.0 | 1.72 | .990 | 190 |
| | | 1988 | 1.4 | 45.8 | 28.8 | 20.7 | 3.3 | 1.79 | .902 | 191 |
| | Navy-Wide | 1987 | 2.6 | 38.3 | 34.4 | 19.3 | 5.4 | 1.86 | .939 | 439 |
| | | 1988 | 5.0 | 39.9 | 30.0 | 18.1 | 7.0 | 1.82 | 1.015 | 437 |
| Female | NAS NI | 1987 | 5.1 | 38.6 | 33.4 | 20.3 | 2.6 | 1.77 | .923 | 219 |
| | | 1988 | 3.0 | 36.6 | 35.9 | 18.4 | 6.0 | 1.88 | .951 | 230 |
| | NAS MFT | 1987 | 6.1 | 22.9 | 25.9 | 35.9 | 9.2 | 2.19 | 1.110 | 19 |
| | | 1988 | 5.0 | 36.5 | 20.1 | 34.6 | 3.8 | 1.96 | 1.055 | 21 |
| | Navy-Wide | 1987 | 0.7 | 37.8 | 41.3 | 14.9 | 5.3 | 1.86 | .874 | 72 |
| | | 1988 | 1.8 | 39.9 | 31.8 | 21.4 | 5.0 | 1.88 | .945 | 69 |
| **Age** | | | | | | | | | | |
| NAS NI | 17-19 | 1987 | 9.4 | 43.4 | 28.3 | 18.9 | 0.0 | 1.57 | .904 | 11 |
| | | 1988 | 7.0 | 25.4 | 60.6 | 7.0 | 0.0 | 1.68 | .709 | 14 |
| | 20-29 | 1987 | 9.3 | 43.5 | 32.3 | 12.6 | 2.3 | 1.55 | .909 | 885 |
| | | 1988 | 4.5 | 43.6 | 32.5 | 14.1 | 5.2 | 1.72 | .943 | 947 |
| | 30-39 | 1987 | 6.6 | 35.8 | 38.1 | 17.1 | 2.5 | 1.73 | .906 | 472 |
| | | 1988 | 2.2 | 32.8 | 37.0 | 22.3 | 5.7 | 1.97 | .932 | 503 |
| | 40-49 | 1987 | 5.4 | 39.1 | 34.8 | 18.5 | 2.2 | 1.73 | .903 | 83 |
| | | 1988 | 0.0 | 42.0 | 30.0 | 23.0 | 5.0 | 1.91 | .922 | 93 |
| | 50+ | 1987 | 0.0 | 0.0 | 50.0 | 50.0 | 0.0 | 2.50 | .633 | 2 |
| | | 1988 | 0.0 | 0.0 | 75.0 | 25.0 | 0.0 | 2.25 | .481 | 4 |

Table 5 (cont) - Weighted[1] Summary of 1.5 Mile Run Categories at NAS North Island (intervention), NAS Moffett (control 1), and Navy-Wide Sample (control 2) in 1987, 1988 in Percentages

| | Group | | 0 Fail | 1 Satisfactory | 2 Good | 3 Excellent | 4 Outstanding | Mean (category) | SD (category) | N |
|---|---|---|---|---|---|---|---|---|---|---|
| NAS MFT | 17-19 | 1987 | 0.0 | 43.8 | 43.8 | 12.4 | 0.0 | 1.69 | .699 | 3 |
| | | 1988 | 0.0 | 61.0 | 30.5 | 8.6 | 0.0 | 1.48 | .661 | 4 |
| | 20-29 | 1987 | 11.2 | 32.5 | 33.8 | 16.1 | 6.4 | 1.74 | 1.064 | 118 |
| | | 1988 | 1.7 | 47.4 | 23.2 | 23.0 | 4.8 | 1.82 | .967 | 121 |
| | 30-39 | 1987 | 6.7 | 31.7 | 34.6 | 21.1 | 5.9 | 1.88 | 1.018 | 76 |
| | | 1988 | 3.2 | 34.4 | 34.7 | 25.4 | 2.3 | 1.89 | .907 | 77 |
| | 40-49 | 1987 | 0.0 | 53.8 | 30.8 | 15.4 | 0.0 | 1.62 | .766 | 12 |
| | | 1988 | 0.0 | 27.3 | 45.5 | 27.3 | 0.0 | 2.00 | .772 | 10 |
| | 50-59 | 1987 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — | — | 0 |
| | | 1988 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — | — | 0 |
| Navy-wide | | | | | | | | | | |
| | 17-19 | 1987 | 0.0 | 27.3 | 45.5 | 18.2 | 9.1 | 2.09 | .907 | 8 |
| | | 1988 | 10.0 | 60.0 | 10.0 | 0.0 | 2.0 | 1.6 | 1.291 | 8 |
| | 20-29 | 1987 | 2.1 | 47.1 | 29.7 | 16.5 | 4.6 | 1.75 | .917 | 238 |
| | | 1988 | 5.0 | 42.1 | 30.6 | 18.7 | 3.6 | 1.74 | .942 | 236 |
| | 30-39 | 1987 | 4.9 | 25.2 | 41.0 | 24.4 | 4.6 | 1.99 | .938 | 191 |
| | | 1988 | 2.4 | 22.7 | 27.3 | 28.6 | 6.9 | 2.09 | 1.004 | 190 |
| | 40-49 | 1987 | 2.8 | 22.0 | 43.2 | 23.6 | 8.4 | 2.13 | .957 | 71 |
| | | 1988 | 0.0 | 27.0 | 45.6 | 19.1 | 8.3 | 2.08 | .900 | 69 |
| | 50-59 | 1987 | 0.0 | 0.0 | 33.3 | 33.3 | 33.3 | 3.00 | — | 3 |
| | | 1988 | 0.0 | 33.3 | 33.3 | 0.0 | 33.3 | 2.33 | 1.63 | 3 |
| Rank | | | | | | | | | | |
| Officer | NAS NI | 1987 | 2.1 | 19.7 | 43.9 | 29.7 | 4.6 | 2.15 | .863 | 204 |
| | | 1988 | 1.1 | 21.0 | 33.4 | 32.4 | 12.2 | 2.34 | .977 | 226 |
| | NAS MFT | 1987 | 6.6 | 14.8 | 23.4 | 33.6 | 21.5 | 2.49 | 1.208 | 16 |
| | | 1988 | 0.0 | 16.7 | 18.6 | 33.4 | 31.3 | 2.79 | 1.097 | 16 |
| | NAVY-WIDE | 1987 | 2.1 | 14.6 | 42.6 | 31.2 | 9.5 | 2.31 | .914 | 109 |
| | | 1988 | 0.0 | 13.7 | 37.0 | 33.4 | 15.9 | 2.51 | .924 | 105 |
| Enlisted | NAS NI | 1987 | 9.5 | 44.3 | 31.9 | 12.5 | 1.8 | 1.53 | .893 | 1199 |
| | | 1988 | 4.6 | 42.4 | 35.5 | 13.8 | 3.8 | 1.70 | .896 | 1247 |
| | NAS MFT | 1987 | 8.7 | 36.8 | 34.9 | 15.7 | 4.0 | 1.70 | .970 | 191 |
| | | 1988 | 1.9 | 47.4 | 27.9 | 21.5 | 1.4 | 1.73 | .866 | 194 |
| | NAVY-WIDE | 1987 | 2.6 | 41.3 | 33.9 | 17.4 | 4.9 | 1.81 | .921 | 402 |
| | | 1988 | 5.4 | 43.4 | 29.2 | 16.4 | 5.6 | 1.73 | .985 | 401 |

[1] Weighted to the entire U.S. Navy in 1988 by age and sex category.

Table 6 - Weighted[1] Summary of Overall Physical Readiness Test (PRT) Score [2] at NAS North Island (intervention), NAS Moffett (control 1), and Navy-wide Sample (control 2) in 1987, 1988 in Percentages

| | Group | | 0 Fail | 1 Satisfactory | 2 Good | 3 Excellent | 4 Outstanding | Mean (category) | SD (category) | N |
|---|---|---|---|---|---|---|---|---|---|---|
| **Overall PRT** | | | | | | | | | | |
| | NAS NI | 1987 | 12.4 | 27.9 | 32.3 | 17.2 | 10.2 | 1.85 | 1.156 | 1464 |
| | | 1988 | 5.1 | 29.8 | 29.5 | 21.1 | 14.4 | 2.10 | 1.132 | 1554 |
| | NAS MFT | 1987 | 20.5 | 31.9 | 29.0 | 10.6 | 8.0 | 1.54 | 1.165 | 156 |
| | | 1988 | 17.8 | 34.0 | 20.8 | 17.5 | 9.8 | 1.68 | 1.235 | 155 |
| | Navy-wide | 1987 | 8.5 | 35.7 | 25.9 | 16.7 | 13.3 | 1.91 | 1.178 | 480 |
| | | 1988 | 7.8 | 36.1 | 25.6 | 16.3 | 14.2 | 1.93 | 1.184 | 490 |
| **Sex** | | | | | | | | | | |
| Male | NAS NI | 1987 | 13.0 | 28.1 | 32.0 | 16.5 | 10.4 | 1.83 | 1.164 | 1243 |
| | | 1988 | 5.0 | 29.9 | 29.2 | 21.2 | 14.7 | 2.11 | 1.136 | 1321 |
| | NAS MFT | 1987 | 20.9 | 33.7 | 27.7 | 9.4 | 8.3 | 1.51 | 0.095 | 139 |
| | | 1988 | 18.9 | 35.2 | 19.6 | 16.0 | 10.3 | 1.64 | 1.248 | 139 |
| | Navy-Wide | 1987 | 9.1 | 36.4 | 25.0 | 16.2 | 13.3 | 1.88 | 1.188 | 407 |
| | | 1988 | 8.3 | 37.4 | 24.9 | 15.0 | 14.5 | 1.90 | 1.194 | 413 |
| Female | NAS NI | 1987 | 6.7 | 25.3 | 35.3 | 24.5 | 8.2 | 2.02 | 1.049 | 221 |
| | | 1988 | 5.3 | 29.3 | 33.0 | 20.5 | 11.9 | 2.04 | 1.092 | 233 |
| | NAS MFT | 1987 | 16.8 | 15.1 | 41.2 | 21.8 | 5.0 | 1.83 | 1.139 | 17 |
| | | 1988 | 6.9 | 22.6 | 33.0 | 32.2 | 5.2 | 2.06 | 1.050 | 16 |
| | Navy-Wide | 1987 | 1.2 | 27.5 | 36.0 | 22.5 | 12.8 | 2.18 | 1.024 | 73 |
| | | 1988 | 3.3 | 22.6 | 33.4 | 29.7 | 10.9 | 2.22 | 1.032 | 77 |
| **Age** | | | | | | | | | | |
| NAS NI | 17-19 | 1987 | 28.3 | 34.0 | 18.9 | 9.4 | 9.4 | 1.38 | 1.251 | 11 |
| | | 1988 | 7.0 | 57.8 | 0.0 | 35.2 | 0.0 | 1.63 | 1.040 | 14 |
| | 20-29 | 1987 | 11.9 | 28.1 | 34.1 | 16.7 | 9.3 | 1.84 | 1.126 | 891 |
| | | 1988 | 5.7 | 27.4 | 34.1 | 17.4 | 15.5 | 2.10 | 1.134 | 945 |
| | 30-39 | 1987 | 8.6 | 24.6 | 32.6 | 20.4 | 13.8 | 2.06 | 1.160 | 477 |
| | | 1988 | 3.0 | 22.6 | 32.2 | 22.2 | 20.1 | 2.34 | 1.122 | 499 |
| | 40-49 | 1987 | 7.6 | 30.4 | 35.9 | 20.7 | 5.4 | 1.86 | 1.012 | 83 |
| | | 1988 | 3.9 | 25.5 | 38.2 | 20.6 | 11.8 | 2.11 | 1.043 | 92 |
| | 50-59 | 1987 | 0.0 | 0.0 | 0.0 | 50.0 | 50.0 | 3.50 | — | 2 |
| | | 1988 | 0.0 | 0.0 | 25.0 | 50.0 | 25.0 | 3.00 | — | 4 |
| NAS MFT | 17-19 | 1987 | 43.8 | 0.0 | 56.2 | 0.0 | 0.0 | 1.12 | 1.021 | 3 |
| | | 1988 | 91.4 | 0.0 | 0.0 | 8.6 | 0.0 | .26 | 0.856 | 4 |
| | 20-29 | 1987 | 22.0 | 36.4 | 21.4 | 10.4 | 9.9 | 1.50 | 1.277 | 89 |
| | | 1988 | 2.4 | 43.6 | 22.4 | 18.6 | 12.9 | 1.96 | 1.177 | 85 |
| | 30-39 | 1987 | 9.1 | 31.7 | 36.0 | 13.8 | 9.5 | 1.83 | 1.095 | 54 |
| | | 1988 | 7.3 | 31.9 | 28.9 | 21.1 | 10.8 | 1.96 | 1.133 | 60 |
| | 40-49 | 1987 | 9.1 | 45.5 | 27.3 | 18.2 | 0.0 | 1.55 | 0.931 | 10 |
| | | 1988 | 0.0 | 50.0 | 33.3 | 16.7 | 0.0 | 1.67 | 0.811 | 6 |

Table 6 (cont) - Weighted[1] Summary of Overall Physical Readiness Test (PRT) Score [2] at NAS North Island (intervention), NAS Moffett (control 1), and Navy-wide Sample (control 2) in 1987, 1988 in Percentages

| | Group | | 0 Fail | 1 Satisfactory | 2 Good | 3 Excellent | 4 Outstanding | Mean (category) | SD (category) | N |
|---|---|---|---|---|---|---|---|---|---|---|
| | 50-59 | 1987 | — | — | — | — | — | — | — | — |
| | | 1988 | — | — | — | — | — | — | — | — |
| Navy-wide | | | | | | | | | | |
| | 17-19 | 1987 | 18.2 | 0.0 | 18.2 | 27.3 | 36.4 | 2.64 | 1.442 | 8 |
| | | 1988 | 10.0 | 50.0 | 20.0 | 10.0 | 10.0 | 1.60 | 1.123 | 8 |
| | 20-29 | 1987 | 6.6 | 46.5 | 25.0 | 12.7 | 9.2 | 1.71 | 1.070 | 223 |
| | | 1988 | 9.3 | 36.7 | 25.4 | 15.9 | 12.7 | 1.86 | 1.179 | 224 |
| | 30-39 | 1987 | 8.9 | 29.0 | 31.6 | 19.7 | 10.8 | 1.94 | 1.132 | 182 |
| | | 1988 | 4.8 | 29.5 | 28.7 | 18.5 | 18.5 | 2.16 | 1.181 | 186 |
| | 40-49 | 1987 | 5.3 | 26.6 | 27.3 | 26.2 | 14.5 | 2.18 | 1.155 | 64 |
| | | 1988 | 0.0 | 30.4 | 26.6 | 21.4 | 21.6 | 2.34 | 1.143 | 69 |
| | 50-59 | 1987 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | 4.00 | — | 3 |
| | | 1988 | 0.0 | 50.0 | 0.0 | 50.0 | 0.0 | 2.00 | — | 3 |
| Rank | | | | | | | | | | |
| Officer | NAS NI | 1987 | 2.1 | 13.3 | 31.1 | 25.6 | 28.0 | 2.64 | 1.089 | 209 |
| | | 1988 | 1.5 | 13.1 | 23.8 | 24.1 | 38.3 | 2.85 | 1.119 | 223 |
| | NAS MFT | 1987 | 35.4 | 19.6 | 45.8 | 0.0 | 0.0 | 1.10 | 1.082 | 2 |
| | | 1988 | 0.0 | 0.0 | 100.0 | 0.0 | 0.0 | 2.00 | — | 1 |
| | Navy-wide | 1987 | 3.5 | 13.7 | 30.0 | 31.4 | 21.4 | 2.54 | 1.086 | 106 |
| | | 1988 | 2.7 | 11.6 | 24.8 | 31.7 | 29.3 | 2.73 | 1.091 | 107 |
| Enlisted | NAS NI | 1987 | 14.1 | 30.3 | 32.4 | 15.6 | 7.6 | 1.72 | 1.117 | 1205 |
| | | 1988 | 5.7 | 32.8 | 31.1 | 19.2 | 11.1 | 1.97 | 1.092 | 1242 |
| | NAS MFT | 1987 | 20.3 | 32.4 | 28.9 | 10.9 | 7.5 | 1.53 | 1.154 | 153 |
| | | 1988 | 18.1 | 34.6 | 20.1 | 17.8 | 9.3 | 1.66 | 1.230 | 152 |
| | NAVY-WIDE | 1987 | 9.1 | 38.6 | 25.3 | 14.8 | 12.2 | 1.82 | 1.165 | 374 |
| | | 1988 | 8.6 | 39.5 | 25.7 | 14.1 | 12.1 | 1.82 | 1.159 | 383 |

[1] Weighted to the entire U.S. Navy in 1988 by age and sex category.
[2] Overall PRT score represents a composite of 1.5 mile run, 2 minute timed sit-ups, 2 minute timed push-ups, and percent body fat scores.

Table 7 - Mean Adjusted[1] Physical Readiness Test (PRT) Category Scores with 95% Confidence Intervals for Those Scoring Category 2 or Less (2=Good 1= Satisfactory 0=Failure) at Time 1 for 1.5 Mile Run and Overall PRT Score. NAS North Island (intervention, N=1111), NAS Moffett (control 1, N=136); and Navy-wide Sample (control 2, N=348)

| | NAS NORTH ISLAND | | NAS MOFFETT | | NAVY-WIDE SAMPLE | | TIME F | GROUP F | TIMEXGROUP F |
|---|---|---|---|---|---|---|---|---|---|
| | 1987 | 1988 | 1987 | 1988 | 1987 | 1988 | | | |
| 1.5 mile run category | 1.3 (1.3-1.3) | 1.6 (1.5-1.6) | 1.4 (1.3-1.5) | 1.6 (1.5-1.7) | 1.4 (1.4-1.6) | 1.5 (1.4-1.6) | 65.3** | .43 | 9.3** |
| Overall Physical Readiness Test Score | 1.3 (1.2-1.3) | 1.7 (1.7-1.8) | 1.2 (1.0-1.3) | 1.4 (1.2-1.6) | 1.3 (1.2-1.3) | 1.5 (1.4-1.6) | 71.3** | 6.9** | 5.2** |

[1] Adjusted to the entire U.S. Navy population in 1988 for age and sex

[2] Overall PRT score represents a composite of 1.5 mile run, 2 minute timed sit-ups, 2 minute timed push-ups, and percent body fat scores.

* P<.05

** p<.01

statistically nonsignificant drops in kcals over the year period (-954 kcals and -213 kcals, respectively). Comparison of kilocalorie changes from 1987 until 1988 showed a significant ($F=10.8$, $P<.01$) time main effect but a nonsignificant time by group interaction (Table 8).

Because motivating sedentary individuals was one of the program goals, we selected for analysis those individuals who reported fewer than 2,000 kcals expended at (1987) baseline. Within this group kcals increased by +1,169 kcals at the intervention worksite ($P<.05$) (Table 8). Comparing the three groups, both the time main effect and the time by group interaction effects were statistically significant ($F=40.8$, $P<.01$ and $F=4.7$, $P<.01$, respectively) for the <2,000 kcal intervention group. However, the percentage of the population falling below the 2,000 kcal level increased at all 3 locations: from 21.8% to 24.5% in the intervention cohort, from 9.2% to 17.1% in the worksite control, and from 20.3% to 26.7% among the Navy-wide sample, indicating no population reduction in physical inactivity.

Questionnaire responses. The questionnaire analysis was based on response rates of 69.9%, 32.3%, and 58.1% for NASNI, NAS Moffett, and the Navy-wide sample, respectively, and must be cautiously interpreted. No nonrespondent analysis was undertaken. These results are presented as exploratory data only and no firm conclusions should be drawn nor action taken based upon these results.

At the intervention worksite, both the personal importance of fitness and the perceived utility of exercise dropped significantly ($P<.05$) over the year-long period (Table 9). None of the scales showed significant improvement over time. When compared to the other cohorts, the only significant time by group interaction ($F=12.6$, $P<.01$) that occurred in the postulated direction was the opportunity to exercise, where at the intervention community the scale increased 0.6 points as opposed to a negative 2.6-point drop at the worksite control and no change at the Navy-wide control (Table 10).

Not occurring in the postulated direction were significant time by group interaction for top level support ($F=3.2$, $P<.05$) favoring greater improvement at control 2 (1.0) than control 1 (0.6), with a slight decrease at intervention (-0.2). The personal importance of fitness measure dropped in all three cohorts as follows: control 1 -2.1,

Table 8 - Mean Adjusted[1] Reported Average Leisure-time Kilocalories (Kcals) Expended per Week[2] with 95% Confidence Intervals for NAS North Island (intervention), NAS Moffett (control 1), and Navy-wide Sample (control 2), in 1987, 1988.

| | NAS NORTH ISLAND | | NAS MOFFETT | | NAVY-WIDE SAMPLE | | TIME F | GROUP F | TIMEXGROUP F |
|---|---|---|---|---|---|---|---|---|---|
| | 1987 | 1988 | 1987 | 1988 | 1987 | 1988 | | | |
| **Overall Kcals/week** | (N=1125) | | (N=70) | | (N=317) | | | | |
| | 4140 (3943-4339) | 3864 (3653-4075) | 3983 (3237-4728) | 3029 (2327-3730) | 3719 (3392-4047) | 3506 (3175-3837) | 10.8** | 2.8 | 1.6 |
| **Inactives (<2,000 Kcals per week) at baseline** | (N=350) | | (N=20) | | (N=111) | | | | |
| | 883 (813-954) | 2052 (1836-2268) | 857 (529-1185) | 2239 (1071-3406) | 1003 (894-1113) | 1548 (1309-1787) | 40.8** | 1.5 | 4.7** |
| **% Below 2,000 Kcals/wk** | 21.8% | 24.5% | 9.2% | 17.1% | 20.3% | 26.7% | | | |

[1] Adjusted to the entire U.S. Navy population in 1988 for age and sex

[2] Computation of average Kcals/wk uses the product of self reported leisure time activity type, duration, and frequency, with activity values obtained from Exercise Physiology, McArdle, Katch, and Katch, 1986.

* p<.05

** p<.01p

Table 9 - Mean Adjusted[1] Questionnaire Response Scores[2] for Participants at NAS North Island (intervention), NAS Moffett (control 1), and Navy-wide Sample (control 2) in 1987 and 1988

| Assessment Areas | | 1987 | 1988 | Change |
|---|---|---|---|---|
| Top Level Support | NAS North Island | 24.7 | 24.5 | -.2 |
| | NAS Moffett | 25.2 | 25.8 | +.6 |
| | Navy-Wide | 26.6 | 27.6 | +1.0 |
| Personal Importance of Fitness | NAS North Island | 25.5 | 24.8 | -.7* |
| | NAS Moffett | 26.7 | 24.6 | -2.1* |
| | Navy-Wide | 22.6 | 22.3 | -.3 |
| Perceived utility of exercise | NAS North Island | 33.4 | 32.7 | -.7* |
| | NAS Moffett | 35.0 | 35.2 | +.2 |
| | Navy-Wide | 36.9 | 36.7 | -.2 |
| Opportunity to Exercise | NAS North Island | 10.4 | 11.0 | +.6* |
| | NAS Moffett | 10.5 | 7.9 | -2.6* |
| | Navy-Wide | 11.8 | 11.8 | 0 |
| Self Rating of Current Fitness | NAS North Island | 2.7 | 2.8 | +.1 |
| | NAS Moffett | 2.7 | 2.8 | +.1 |
| | Navy-Wide | 2.5 | 2.4 | -.1 |

[1] Adjusted to the entire U.S. Navy population in 1988 for age and sex.

[2] These are scaled items obtained from a combination of questionnaire responses with categories ranging from 0 (extremely negative) to 7 (always enough, extremely concerned).

* Significant change ($p<.05$) from 1987 to 1988.

Table 10 - Mean Adjusted[1] Questionnaire Response Scores with 95% Confidence Interval and Univariate F Score for NAS North Island (intervention), NAS Moffett (control 1), and Navy-wide Sample (control 2)

| | NAS NORTH ISLAND | | NAS MOFFETT | | NAVY-WIDE SAMPLE | | TIME F | GROUP F | TIMEXGROUP F |
|---|---|---|---|---|---|---|---|---|---|
| | 1987 | 1988 | 1987 | 1988 | 1987 | 1988 | | | |
| Top Level Support | 24.7 (24.4-25.1) | 24.5 (24.0-24.9) | 25.2 (23.6-27.0) | 25.8 (24.1-27.5) | 26.6 (25.7-27.4) | 27.6 (26.8-28.3) | 1.82 | 17.4** | 3.21* |
| Personal Importance of Fitness | 25.5 (25.2-25.8) | 24.8 (24.5-25.1) | 26.7 (25.6-27.7) | 24.6 (23.5-25.7) | 22.6 (22.0-23.3) | 22.3 (21.7-23.0) | 31.6** | 38.0** | 5.6** |
| Perceived Utility of Exercise | 33.4 (33.8-34.0) | 32.7 (32.1-33.3) | 35.0 (32.9-37.1) | 35.2 (32.9-37.4) | 36.9 (36.0-38.0) | 36.7 (35.7-37.7) | 0.5 | 24.1** | 0.6 |
| Opportunity to Exercise | 10.4 (10.1-10.7) | 11.0 (10.7-11.3) | 10.5 (9.4-11.6) | 7.9 (6.6-9.1) | 11.8 (11.2-12.3) | 11.8 (11.2-12.3) | 8.7** | 14.4** | 12.6** |
| Self Rating of Current Fitness | 2.7 (2.7-2.8) | 2.8 (2.8-2.9) | 2.7 (2.6-2.9) | 2.8 (2.6-3.0) | 2.5 (2.4-2.6) | 2.4 (2.3-2.5) | 1.2 | 29.5** | 2.3 |

[1] Adjusted to the entire U.S. Navy population in 1988 for age and sex

* $p<.05$

** $p<.01$

intervention -0.7, control 2 -0.3 with significant time main effect ($F=31.6$, $P<.01$) and time by group interaction ($F=5.6$, $P<.01$).

## Discussion

The intervention was designed to remove environmental barriers to exercise and thereby enable individuals to integrate physical activity into daily routines. Over the one-year study period, the 1.5-mile run times improved by a mean of 18 seconds (2.4% of mean time). Mean overall physical readiness test (PRT) score, a composite of the 1.5-mile run, push-ups, sit-ups, and percent body fat component scores, improved 0.3 category points (16% of mean score) on the four point scale ranging from failure to outstanding. Both of these changes were significantly greater ($P<.01$) than in a similar community and in a Navy-wide sample. Further, the improvement in the 1.5-mile run and the overall PRT score was not limited to any single subgroup of the population, but was generally seen throughout the population.

Since inactive people have the most to gain from increasing their fitness level, it is important to examine whether the intervention was successful in changing the exercise performance within this subgroup. While 12.4% failed the physical readiness test at the intervention worksite in 1987, only 5.1% failed in 1988. Likewise, the 1.5-mile run failures dropped from 8.4% in 1987 to 4.0% in 1988. Looking at only those who scored at a "good" or below level at baseline, total PRT points improved by 0.4 category points, while run time category improved by 0.3 points. Both of these improvements were statistically significantly greater ($P<.01$) than those seen in either control group.

Total calculated kcals expended did not increase as expected in any of the three groups. This lack of significantly increased kilocalorie expenditure is inconsistent with the finding of improvement on fitness testing. The Johnson and Johnson worksite study found a convergence of these two measures which strengthened the argument that real change had occurred.[3]

While it is not entirely certain what amount of kcals expended per week will produce positive health effects, Paffenbarger concluded that positive health benefits occur at a level above 2,000 total kcals expended per week.[18] Using 2,000 leisure-time calories as a cutoff at

baseline, in the intervention group those who reported expending fewer than 2,000 kcals per week increased their kcal expenditure from 883 to 2,052 kcals. This 1,169 kcal change was statistically significant in both time main effect and time by group interaction effect ($P<.01$) when compared to the control community and the Navy-wide sample. In contrast to this finding, in all three cohorts a greater percentage of the population had slipped below the 2,000 kcal per week level by the end of the year (from 21.8% to 24.5% in the intervention cohort, from 9.2% to 17.1% at the community control, and from 20.3% to 26.7% among the Navy-wide sample). Thus, simple regression to the mean, the phenomenon of repeat measurements moving closer to the center of the distribution, is the likely explanation for the increase in mean kcals among those expending less than 2,000 kcals per week at baseline. The finding that the kcal expenditure changed very little overall, coupled with the data showing that the percentage of people below the 2,000 kcal per week level increased slightly, are not consistent with the improvement in run times. This inconsistency could reflect the nonresponse to the questionnaire, on which the energy expenditure results were based, or different reliabilities of the questionnaire and run-time data.

There were no significant improvements noted within the intervention worksite on scaled questionnaire items concerning both the top level support and the opportunity to exercise. The perceived utility of exercise and the personal importance of fitness significantly declined. The single item self-rating of personal fitness, shown to be a key predictor of fitness testing performance, also did not improve despite the fact that the performance on the physical readiness test did.[19] It is possible that the relatively high nonresponse rate to the questionnaire accounted for this general lack of concurrence, that a ceiling effect at baseline occurred, or that the questionnaire measures may not be sensitive enough indicators to detect the small changes seen in the physical readiness test results.

In order for a test to be valid, it must first be reliable. Distance run tests have shown correlations ranging from .75 to .90 indicating high reliability.[20] Further, distance runs have been shown to be related at a sufficient magnitude with laboratory tests of maximal oxygen uptake to conclude that cardiorespiratory function is the

dominant factor reflected by distance running performance. But when evaluating distance run times the user must consider that the performance scores reflect complex determinants. Individual differences on the distance runs may reflect characteristics other than cardiorespiratory endurance. Motivation, as influenced by rewards, competition, audiences, reference standards, and different forms of feedback, has also been shown to influence performance.[21]

Because many of the occupations within the U.S. Navy demand a physically fit person, and because military bearing and appearance are held in high regard, the fitness gains made at the intervention site are important to the organization. From the organizational viewpoint, the program was a success. Whether the magnitude of these observed changes have administrative or policy significance is a different matter. While the fitness levels did improve, the magnitude of improvement was not impressive. How an 18-second gain in a 1.5-mile run time translates into actual gain in health status and longevity can be answered only indirectly by inference from other research.

The following argument can be made that improvement in run time could translate into health gains. Cardiorespiratory fitness reflects the functional capacities of the heart, blood vessels, blood, lungs, and relevant muscles during various types of exercise demands. Endurance running has been widely used to test cardiorespiratory fitness.[21] While no single field or laboratory test can be expected to evaluate, with specificity and precision, all of the individual factors that determine a person's cardiorespiratory fitness, the laboratory test that has achieved widest acceptance as a composite measure of cardiorespiratory fitness is the direct measurement of maximal aerobic power: maximal oxygen uptake ($VO_2$ max). Performance on distance running tests of one mile or longer have been shown to correlate significantly with maximal aerobic power, with correlation coefficients varying between -.22 to .90.[21] Thus, improvement in aerobic fitness has been shown to be associated with concomitant improvements in $VO_2$ max. Finally, positive changes in $VO_2$ max have been shown to be associated with a decrease in total coronary heart disease risk.[3]

While the above sequence makes qualitative sense, it is not presently possible to show precisely how a 2.4% decrease in mean run

time quantitatively relates to $VO_2$ max nor how these improvements in $VO_2$ max precisely relate to changes in coronary risk. Concerning predictive validity of run tests, although persons continuing a physical conditioning program will have a lower risk of coronary heart disease (CHD) than if they were sedentary, it is not possible to predict the distance run performance that will "protect" a person from CHD.[21] Conservatively, it is concluded that while the intervention was effective in improving exercise testing performance, present knowledge is insufficient to make public health statements concerning the intervention's protective effects on the future health of the population.

Generalizability. The environmental and social changes associated with the intervention can easily be applied in a wide variety of settings. In occupations having a predominantly male workforce with well-defined fitness standards (such as police and firefighters), very little modification would be necessary.

The literature is very sparse on studies reporting physical activity change using public health intervention models. In fact, the Johnson and Johnson study was the first to report encouraging results concerning improved overall fitness measures in a multicomponent health promotion program.[3] In addition to the possible lack of evaluation efforts being made, a second explanation for this sparsity of reporting is the tendency toward selective publication of positive results. Since exercise habits are such an exceedingly difficult behavior to modify, this explanation seems highly plausible.

It has been shown that through intensive clinical one-on-one interventions physical fitness can be improved.[3] The challenge is to find effective ways of reaching large numbers of people in order to reach our nation's exercise and physical fitness health goals. This simple intervention was successful in improving the fitness level of community members as reflected by physical readiness testing.

Timely program evaluation not only helps to establish the knowledge base on which to plan future programs, but can be immediately useful in making midcourse corrections and in providing feedback to the organization's leaders. Future research should be aimed at testing appropriately modified programs in a variety of settings, and then

expanding the breadth of the research to include not only physiological outcomes (physical fitness performance, VO2 max improvements) but also to the ultimate outcomes of possible improved health and longevity. The recommendation has been made by the U.S Preventive Services Task Force for all adults to increase their physical activity levels.[1] Quantifying the linkage from improved aerobic capacity to the primary prevention of such medical conditions as obesity, diabetes mellitus, and coronary heart disease is still necessary before stronger recommendations can be made or before cost-benefit analyses can be attempted.

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Inactivity is the risk factor with potentially the greatest public health impact according to the 1989 U.S. Preventive Services Task Force report. This study reports changes in the physical fitness level following simple changes aimed at enabling community members to more easily adapt active life-styles.

Simple environmental and social alterations were made at a San Diego Naval Air Station. A cohort of active-duty personnel from within this community (n=1,609) was administered both a physical readiness test (PRT) and a lifestyle questionnaire at baseline and at one year. The PRT consisted of a 1.5-mile timed run, sit-ups, push-ups, and percent body fat components while the questionnaire addressed demographics, current exercise behavior, and attitudes toward exercise. Similar measures were taken within a comparison community cohort (n=217) and within a Navy-wide sample cohort (n=546).

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Overall PRT category and 1.5-mile run time both improved significantly ($P < .05$) over time at the intervention community (0.3 category points and 18 seconds, respectively). The increase was significantly greater ($P < .01$) than at either the control community or within the Navy-wide sample. Subgroup analysis showed that at the intervention community 12.4% failed the overall fitness test in 1987, but only 5.1% failed in 1988. Similarly, the 1.5-mile run failures decreased from 8.4% to 4%. Reported leisure time kilocalorie expenditure showed no significant improvement.

This simple program was successful in improving fitness performance. The improvement was distributed throughout the community and included those who were substandard at baseline. Similar programs could easily be adopted in a variety of communities.